lie. The ciliated tentacula, like those of *Vesicularia*, are eight in number, and do not possess the motionless hair-like processes which project from the back of each in *Bowerbankia*.

Although too much importance must not be attached to the actual number of tentacula surrounding the oral aperture, the tendency to multiply those organs must not be altogether forgotten. Thus, while there are but eight in *Vesicularia*, *Bowerbankia densa* and *Bowerbankia repens* possess respectively ten and twelve.

Both *Bowerbankia* and *Vesicularia* agree in the uniserial and unilateral distribution of the polypes, but in the present instance the cells are arranged in linear and bilateral clusters.

February 26, 1857.

The LORD WROTTESLEY, President, in the Chair.

The following communications were read :—

I. "Observations on the Natural Affinities and Classification of Gasteropoda." By JOHN DENIS MACDONALD, Assistant Surgeon R.N. Communicated by Captain DENHAM, R.N., F.R.S. Received January 13, 1857.

(Abstract.)

During his sojourn among the Feejee Islands, the author devoted much time to the anatomical investigation of recent Gasteropoda, with the view of discovering such indications of affinity in the details of structure as might serve as a basis for a natural arrangement of the order; and the present paper is designed to give a statement of some of the results of his researches, in order that the affinities of structure developed may be fairly examined and taken for what they are worth as principles of classification.

After pointing out objections to the foundation of primary divisions among the Gasteropoda on characters derived from the shell or from modifications of the respiratory organs, the author observes in respect of the value of sexual characters, that when the distinguishing features of a class are once satisfactorily determined, and this contains

forms in which the sexes are either separate, or combined in the individuals, no other characters can be of greater importance in establishing primary divisions. As a means of further subdivision according to natural affinities, he suggests distinctive characters derivable from the auditory sacs and concretions, and from the oral, lingual and gastric dental organs.

In Mollusca, as in Fishes, the auditory concretions present themselves in one of two forms, viz. solitary lapilli, usually named *otolithes*, or groups of small granules of a rounded oval or irregular shape, which have been designated by the term *otoconia*. The lingual teeth are either set together on a short and broad lingual membrane, and form what the author calls a *lingual pavement*, or on a narrow longitudinal band termed *lingual ribbon* or *strap*. The latter usually consists of a median *rachis* flanked by two lateral portions or *pleuræ*; but in some cases the *rachis*, and in others the *pleuræ* are absent, and the number of longitudinal rows of teeth in these divisions may also differ in different genera. The fore part of the lingual membrane is supported by cartilage, so curved and fashioned as to receive the lingual sac behind and form a basis to the tongue itself projecting in front. This lingual cartilage may consist of a single piece thinned in the middle line, or of two or four distinct pieces, similarly arranged and wrapped together by muscle and ligament. The oral dental organs or *labial plates* are disposed either horizontally or laterally. In the former case a single plate may occupy the upper lip, or there may be two guarding the aperture of the mouth, and corresponding with both upper and lower lip, but the lateral plates are always in pairs. Gastric teeth occur in the Aplysiadæ and Bullidæ.

After pointing out further differences in the form and arrangement of the dental apparatus in different genera, the author thus describes the mode of development of the lingual teeth. "The lingual sac at first appears as a little cæcal process appended to the inferior part of the œsophagus, where it joins the oral cavity. In the median line of the floor of this sacculus, a few minute plates disposed in a longitudinal row form the rudiment of the future rachis, and the progress of their development may be distinctly traced on examining them, *seriatim*, from before backwards, in which direction, as their growth advances, they acquire a more perfect form. The internal row of pleural plates now makes its appearance, their development proceeding in a similar way; and after this follow the others according to their posi-

tion, the more internal arising first. Thus the whole ribbon of dental organs increases in length and breadth by additions made respectively to its anterior extremity and sides; and each transverse row gradually moving backwards by the continued development and growth of others anterior to it, causes elongation of the lingual sac, which only attains its perfect state when these processes are at an end. The idea, therefore, that the new teeth are developed from behind forwards and successively brought into use, as in sharks and rays among fishes, does not appear to me to be correct."

In the annexed Table a rough arrangement is given of a considerable number of genera grouped together by the characters above referred to. Although the author thinks it improbable that any genera opposed to each other in those fundamental particulars can be intimately related, yet the facts are not advanced as the basis of a new classification, but simply that they may yield their own weight, as so many available tests of affinity.

Sexes separate.				Sexes combined.			
Otolithes.		Otoconia.		Otoconia.		Otolithes.	
Strap.	Pavement.	Pavement.	Strap.	Strap.	Pavement.	Pavement.	Strap.
Oxygyrus.	Triphoris.	Solarium.	Helicina.	Patella.	Limax.	Ianthina.	Vermetus.
Atlanta.	——	——	Naviccla.	Dentalium.	Parmacella.	——	Serpuloiães.
Carinaria.	——	——	Neritina.	——	Helix.	——	Pileopsis.
Cardiapoda.	——	——	Nerita.	——	Helicella.	——	Hipponyx.
Firola.	——	——	Trochus.	——	Carocolla.	——	Pedicularia.
Cerophora.	——	——	Delphinula.	——	Bulimus.	——	Glaucus.
Egea.	——	——	Turbo.	——	Partula.	——	Eolidia.
Syncera.	——	——	Stomatella.	——	Vertigo.	——	&c.
Melania.	——	——	Broderipia.	——	Physæ.	——	——
Truncatella,	——	——	Haliotis.	——	Planorbis.	——	——
Planaxis.	——	——	&c.	——	Scarabus.	——	——
Litiopa.	——	——	Cyclophorus.	——	Conovulus.	——	——
Litorina.	——	——	Diplommatin	a. ——	Siphonaria.	——	——
Lacuna.	——	——	Pupina.	——	Amphibola.	——	——
Natica.	——	——	——	——	Tornatella.	——	——
Triton.	——	——	——	——	Dolabella.	——	——
Ranella.	——	——	——	——	Bulla.	——	——
Terebellum.	——	——	——	——	Cylichna.	——	——
Strombus.	——	——	——	——	Doris.	——	——
Mitra.	——	——	——	——	Pleurobranch us.	——	——
Harpa.	——	——	——	——	Phyllirrhoe.	——	——
Oliva.	——	——	——	——	——	——	——
Ricinula.	——	——	——	——	——	——	——
Purpura.	——	——	——	——	——	——	——
Murex.	——	——	——	——	——	——	——
Muricidea.	——	——	——	——	——	——	——
Cyrtulus.	——	——	——	——	——	——	——
Tritonidea.	——	——	——	——	——	——	——
Buccinum.	——	——	——	——	——	——	——
Nassa.	——	——	——	——	——	——	——
Pusiostoma.	——	——	——	——	——	——	——
Columbella.	——	——	——	——	——	——	——
Conidea.	——	——	——	——	——	——	——
Pleurotoma.	——	——	——	——	——	——	——
Terebra.	——	——	——	——	——	——	——
Conorbis.	——	——	——	——	——	——	——
Conus.	——	——	——	——	——	——	——

The following Table exhibits a further subdivision of the first series, according to the characters of their dental organs.

- Lingual dental organs.
  - Septiserial.
    - Mouth, unarmed. — Oxygyrus. Atlanta. Carinaria. Cardiapoda. Firola. Cerophora.
    - Lateral, labial plates. — Egea. Syncera. Melania. Truncatella. Planaxis. Litiopa. Litorina. Lacuna. Natica. Triton. Ranella. Terebellum. Strombus.
  - Triserial.
    - Rachis, armed.
      - Strap, short and broad. — Mitra.
      - Strap, long and narrow.
        - Simple hooks in the Pleuræ. — Harpa. Oliva. Ricinula. Purpura. Murex.
        - Broad plates in the Pleuræ, apparently fixed. — Muricidea. Cyrtulus. Tritonidea.
        - Plural plates, articulated, moveable. — Buccinum. Nassa. Pusiostoma.
    - Rachis, unarmed. — Columbella. Conidea.
  - Biserial. — Pleurotoma. Terebra. Conorbis. Conus.

Murex, Triton, and *Ranella* have always been associated together as members of one family by universal consent, and it must be confessed that the external resemblance between them is very remarkable; but on comparing the lingual and labial dental organs of *Triton* or *Ranella* with those of *Murex*, it will be at once perceived that the latter genus can have no immediate affinity with either of the former genera.

The aperture of the proboscis in *Murex* is transverse, and armed with two horizontally arranged dental plates, connected laterally by the minute semi-calcified cells which line this part. The upper plate presents a rough palatal surface, with an anterior encrusted cutting border, much resembling that of the crescentic mandible of *Limax* or *Helix*; whereas the dental plates of *Triton* and *Ranella* consist of oblique rhombic cells identical in character with those of *Cyclophorus* or *Natica*, disposed laterally. Again, on comparing the lingual strap of *Murex* with that of *Triton* or *Ranella*, we remark, first, that each transverse row of the former consists of three members, viz. one in the rachis, and one in each pleura, while in the two latter cases the pleuræ present two additional elements; thus there are seven series of dental plates in the strap. The tongue-strap of *Murex*, moreover, is lengthy like that of *Purpura* and *Ricinula*, both of which genera are more closely allied to *Murex* than perhaps any others referred to its family.

The strap of *Triton* and *Ranella*, on the other hand, is comparatively much shorter, and singularly enough more nearly approaches that of *Pileopsis* or *Vermetus*, not only in general proportions, but also in the actual number and configuration of the dental plates and processes. Now with these facts before us, it will be scarcely worth while entering further into the characters of the lingual dentition of *Murex*, *Triton*, and *Ranella*, but the most superficial examination of the figures (which accompany the communication) will show that *Murex* must be separated from its assumed alliance with *Triton* and *Ranella*, while the close relationship of the two latter genera gains additional support.

On comparing the lingual dentition of the genus *Cyrtulus* with that of *Tritonidea* of Swainson (the *Polia* of Gray), both are found to be naturally allied by characters which very distinctly manifest a family relationship, and Swainson's genus *Muricidea*, with several

others, must also be referred to this group. The lengthy triserial ribbon of *Cyrtulus*, or *Tritonidea*, for example, exhibits no true or immediate affinity with the comparatively short and septiserial dental armature of *Triton* or *Ranella*. Thus the author is induced to dissent from Mr. Gray's view that *Tritonidea* is allied to *Triton*, but agrees with him that the *Buccinidæ*, forming an equally characteristic natural family, are very close at hand.

The lingual dentition, and in fact the whole anatomy of *Terebra*, most unequivocally refer it to the *Conidæ*, and not to the *Buccinidæ*, amongst which it is at present received.

The author has not been able to detect lingual cartilages of the usual character in *Conus*, *Conorbis*, or *Terebra*, but the walls of the tongue-sac are stout, tough, and distinctly cartilaginous in structure; indeed the whole organ, including its armature, very much resembles the dental cheek-pouches of some Pteropods.

The lingual ribbon of *Pleurotoma* is exceedingly minute, and the parietes of the sac are not of that dense and unyielding character which they exhibit in *Conus*, *Conorbis**, and *Terebra*. Moreover, in *Pleurotoma* the little lingual membrane is supported by two rounded masses of cartilage composed of large spheroidal cells. The rachis appears to be absent altogether, and there is but a single row of elongated, slightly curved, and sharp-pointed teeth (differing considerably from those of *Conus* and *Terebra*) in the pleuræ.

The tongue-strap of *Mitra*, although remarkably short, is triserial like that of *Murex*, *Purpura*, &c.; but the author has invariably found that in those *Mitræ* in which the sculpturing of the shell was transverse, the pleural teeth were simple, uncinate, and mobile, while in those species characterized by a smooth surface or longitudinal sculpturing, the dental processes were small, straight, and numerous, arising just within the posterior border of broad basal plates. This difference is exactly such as exists between the lingual dentition of the respective groups to which *Murex* and *Tritonidea* belong.

Harpa and *Oliva* are very closely allied, by the general configuration of the body and the characters of the lingual dentition, though it must be remembered that the tongue-strap in the former is so very

* Several specimens of a recent species of this genus (hitherto known only in a fossil state) were obtained from depths ranging between 10 and 20 fathoms, within the barrier reefs surrounding the Feejee Islands.

minute, compared with the whole bulk of the animal, as to appear quite rudimentary. The simple lateral uncini, moreover, are only distinctly visible towards the posterior extremity of the sac. Both these genera seem to be more intimately related to *Murex* and its congeners than to the *Buccinidæ*.

Triphoris is now, as it would appear from the characters of its shell alone, placed with *Cerithium*, but the comparison of the internal anatomy of those genera offers no countenance to their supposed affinity; thus, single spherical otolithes occupy the auditory sacs of *Triphoris*, while those of *Cerithium* contain otoconia. The proboscis of the former is long and retractile. The lingual membrane of *Triphoris* besides, though long and ribbon-like, supports a multiserial pavement of minute teeth, while that of *Cerithium* is septiserial, resembling in many particulars the tongue-strap of *Pupina* and allied forms.

The *Columbellæ* deserve to be elevated to the rank of a family, distinguished from the *Buccinidæ* by the unarmed rachis, and curved versatile pleural teeth of the tongue-strap.

Although not fully satisfied of the propriety of separating the genus *Conidea* from *Columbella*, the author thinks there can be no doubt that *Pusiostoma*, formerly placed with the *Columbellæ*, forms a very distinct genus clearly referable to the *Buccinidæ*.

As great difference of opinion has always existed as to the distribution of the sexes amongst Gasteropods, so far the author is unable to vouch for the whole truth of the arrangement above given, but he thinks that if there is anything incongruous in it, the correction of errors in that particular would seem to be most likely to restore harmony and support the truth of the system.

In the course of his inquiries the author was impressed with the fact, that various genera of terrestrial gasteropods, which agree with each other as far as regards their respiratory organs and mode of respiration, differ essentially in their general organization, whereas they are in this respect severally related to fluviatile and marine genera, which are obviously constructed on the same anatomical type.

In this way a terrestrial genus, having few structural points of agreement to connect it laterally, as it were, with others of the same habit, forms a member of a beautifully connected natural series, traceable from it through fluviatile and littoral forms to others which are altogether marine.

As an example of these relations the following Table is given, and it might have been extended and rendered more complete, had the author not preferred to limit it to such cases as have come under his own examination.

	Sexes combined.	Sexes separate.	
	Otoconia.	Otoconia.	Otolithes.
	Pavement.	Lingual ribbon.	Ribbon.
	Teeth numerous, uniform in character.	Rachis and Pleuræ multiserial.	Rachis uniserial, Pleuræ triserial.	Rachis uniserial, Pleuræ triserial.
Terrestrial...	Helix.	Helicina.	Cyclophorus.	Egea.
	Bulimus.	——	Diplommatina.	——
	——	——	Pupina.	——
Fluviatile...	Physa.	Navicella.	?	Melania.
	Planorbis.	Neritina.	——	——
	——	——	——	——
Leading to purely marine genera.	Scarabus.	Nerita.	Cerithium.	Hydrobia.
	Conovulus.	Turbo.	——	Planaxis.
	Siphonaria.	Stomatella.	——	Litiopa.
	Amphibola.	Broderipia.	——	——

This Table shows the natural affinities of four principal divisions of terrestrial gasteropods, proceeding, as it were, in parallel lines, without any very obvious lateral connexions, through fluviatile and littoral forms, conducting to certain marine genera distinguished by this alliance from all others having no terrestrial representatives, and being therefore more restrictedly marine. It may be remarked that the importance of the characters placed at the head of the Table has been proved by the comparison of other anatomical particulars in those genera, and so far their efficiency in other cases is substantiated.

The author adds the following observations on the anatomy of the *Siphonaria* and *Amphibola*, as bearing on their position in the first series of the foregoing Table :—

"*Siphonaria* appears to enjoy the power of breathing in both air and water with equal facility, and on examination, we find the respiratory surface so constituted as to afford a ready explanation of the fact. Thus, in connexion with a narrow, combed, or rather transversely plaited gill, numerous vessels ramify extensively, and

anastomose freely upon the roof of the respiratory chamber. The mouth is armed with lateral labial plates, and the lingual dentition is not unlike that of *Amphibola*, to which genus it is further related by the absence of tentacula, and the general configuration of its head.

"*Amphibola* exhibits a close relationship to the Pulmonifera in many essential anatomical points, but it has a veritable combed gill, which, arising from a deep recess on the left side of the branchial chamber, and thence passing obliquely forwards towards the right side, terminates in a pointed extremity, in front of which there is a small glandular body, probably a renal organ. The margin of the mantle may be traced continuously round the neck and the base of the foot, being attached in its entire extent, with the exception of a small portion which arches over a narrow respiratory opening on the right side of the nape. The lingual sac is small, like a cæcal process appended to the antero-inferior part of the œsophagus. The dental organs present a pavement of narrow basal plates with very long and gently curved cusps. The teeth of the central series are much larger than the rest, and exhibit a remarkable conformation; thus a rounded process projects in the middle and several minute denticulations arm its base on either side. I have not succeeded in detecting either lingual cartilages or labial plates in my spirit-preserved specimens, and but for the support furnished by analogy, I would incline to the belief that they are absent in the present case.

"The remark made by Mr. Woodward in his very valuable little work the 'Manual of Mollusca,' that the anomalous genus *Amphibola* has an unusually broad tongue armed with teeth similar to those of the snail, is not quite correct. The misconception most probably originated in the inspection of a preparation belonging to Mr. Wilton of Gloucester, and from which Mr. Woodward's figure has been taken, as 'part of the tongue of *Amphibola avellana*;' but having myself dissected several specimens of this very species obtained at New Zealand, I am satisfied that Mr. Wilton's preparation has been by some accident improperly named.

"The general scheme of the generative system in *Amphibola* corresponds very closely with that of *Helix*, *Bulimus* and such Pulmonifera. The ovarium is imbedded in the liver near the summit of its spiral turns, and a small convoluted oviduct leads downwards and forwards along its inner or concave side. The testis lies con-

siderably in advance of the ovary; the intromittent organ forms a prominence in the floor of the respiratory chamber, and finally the generative orifices open on the right side."

II. "On the Sea Saw-dust of the Pacific." By JOHN DENIS MACDONALD, Esq., Assistant Surgeon R.N. Communicated by Captain DENHAM, R.N., F.R.S. Received January 13, 1857.

(Abstract.)

In this communication the author gives a description (illustrated by figures) of the remarkable little algal so frequently met with in the South Pacific, scattered over the surface of the water in broad streaks and patches of a pale yellowish-brown tint, and which is known under the name of "Sea Saw-dust."

After adverting to the occurrence of a similar phenomenon in other parts of the globe, and citing the account given of the *Trichodesmium erythræum* of the Red Sea by MM. Evernor Dupont and Montagne, together with a description extracted from the 'Colombo Herald' of May 14, 1844, of what was obviously an example of a vegetable scum of the same kind occurring on the sea off Ceylon, the author remarks, that in the instances met with by himself he did not recognize the fœtid odour so generally and pointedly spoken of in the accounts of others. He then states results of his own observation as follows:—

"It was rather difficult at first to determine whether our species is to be referred to the Oscillatoridæ or the Confervidæ. In the latter, a linear series of tubular cells compose the filaments, which are thus said to be jointed, but in the former, although the filaments are tubular, simple and continuous without actual joints, a pseudo-jointed appearance is presented by the apposition of the little masses of contained colouring matter. Notwithstanding, having submitted the 'sea saw-dust' of the Pacific to microscopic examination on several occasions, I was much inclined to believe that the filaments were actually jointed; and this view is supported by the cir-